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[54] **STRUCTURE AND METHOD FOR MOLDING OPTICAL DISKS**

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[52] **U.S. Cl.** **264/1.33**; 249/114.1; 249/134; 249/135; 264/328.16; 425/810; 427/135

[58] **Field of Search** 264/1.33, 106, 264/107, 328.16; 249/114, 114.1, 116, 135, 134; 425/547, 810; 427/133, 135

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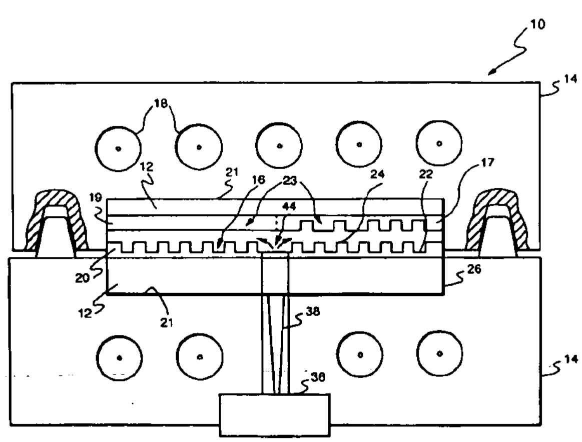
[57] **ABSTRACT**

A method for molding an optical disk comprises: applying a thermally insulative insert coating to at least one thermally insulative mold insert to provide at least one coated mold insert having a reduced surface roughness; positioning the coated mold insert between a thermally conductive mold form and a portion of a thermally conductive mold apparatus; injecting a molten thermoplastic material into the mold apparatus; retaining the material in the mold apparatus for a time sufficient for the molten thermoplastic material to cool below its glass transition temperature to form the optical disk; and ejecting the optical disk from the mold apparatus. In another embodiment, the mold insert is coated or laminated on the mold form with the mold insert having a coefficient of thermal expansion compatible with the coefficient of thermal expansion of the mold form. In another embodiment, the mold insert is fabricated by being applied, cured, and then removed from a release layer.

10 Claims, 6 Drawing Sheets



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RPM (rotations per minute) to about 3000 RPM for a time ranging from about 20 seconds to about 30 seconds, for example. As discussed above, other coating techniques include dip coating, meniscus coating, and spray coating, for example.

The desired thickness of the insert will vary according to the embodiment in which the insert will be used, but generally the thickness will be in the range of about 5 micrometers to about 250 micrometers. In embodiments in which the insert will only be provided on one side of the mold, a thinner layer in the range of about 5 micrometers to about 25 micrometers is more appropriate for even heat transfer. In embodiments where inserts are present on both sides of the mold, thicker layers can be used. These embodiments are desirable for improving disk quality because thicker insulation permits the molding process to be run at lower melt and mold temperatures, but many molding machines are not adapted to include an insert on the smooth side of the mold.

After the insert material is applied and coated, the stamper and insert material are cured. Curing can be performed in a two step process, for example, by baking at about 100° C. for a range of time from about fifteen minutes to about three hours followed by baking in a nitrogen atmosphere at about 200–300° C. for a range of between one hour to three hours.

In some embodiments, several layers of insert material may have to be applied sequentially in order to build up an insert of the appropriate thickness and/or composite structure. After curing, the stamper and insert can be punched and packaged for shipment and/or molding.

FIG. 6 is a view of an insulative mold insert **12** being laminated to a stamper **20** with an adhesive **124** and illustrates another embodiment of the present invention. In this embodiment, an insert, which may comprise any of the materials discussed with respect to FIGS. **2** and **3**, for example, can be applied to the back of a stamper or surface mold form by coating either the mold form or the insert with an adhesive **124** and laminating the two structures together. The adhesive may comprise, for example, a thermoplastic material such as a polyetherimide, acrylic, polyester or other polymer or a thermosetting material such as an epoxy or a thermoplastic/epoxy blend.

Preferably, in the present invention, the insert material is selected to have coefficient of thermal expansion as close to the mold form as feasible. In one embodiment, the insert material comprises KAPTON™ E polyimide having a coefficient of thermal expansion in the plane of the film of about 14–17 ppm/° C. Additionally, in the embodiment, the adhesive comprises a material such as ULTEM™ polyetherimide which does not significantly shrink during curing and has a coefficient of thermal expansion sufficiently close to the thermal expansions of the mold insert and the mold form.

FIG. **7** is a view of another embodiment of the present invention in which insulative mold insert **12** is formed on a release layer **130** above a substrate **128**.

The smooth substrate may comprise a smooth material such as glass or a silicon wafer, for example, or any other highly polished or smooth surface. The release layer may comprise a material such as titanium nitride or gold having a thickness of about 100 angstroms, for example. The release layer is selected to have a lower surface energy than the substrate and thus does not promote adhesion. The release layer can be applied by evaporation or sputtering techniques.

In this embodiment, a smooth free standing insert can be produced by spin coating a solution of liquid insulative mold insert material such as any of the materials discussed with

respect to FIG. **4** onto the substrate which has been coated with a release layer. Preferred materials for the liquid insulative mold insert material include polymer solution such as ULTEM polyetherimide and PYRALIN® polyimide (PYRALIN is a trademark of DuPont Co.). Preferably the insert material is spun to a thickness ranging from about 10 microns to about 30 microns.

After the insert material is applied, the insert is cured and removed from the substrate. Potential removal methods include peeling the insert material using tweezers or fingers, or, to avoid hand or instrument contact, by immersing the substrate and insert in a liquid such as water and allowing the insert to float off the substrate.

The above embodiments of FIGS. **2–3** and FIG. **7** relate to stand alone inserts, whereas the embodiments of FIGS. **3–4** and FIG. **6** relate to inserts that are fabricated directly on stampers or smooth surface mold forms. Stand alone inserts have benefits in that they can be used with conventional stampers and that they can be switched and used with a common stamper for different molding applications. Integral inserts, particularly when spun directly on a stamper as in the embodiment of FIGS. **3–4**, have the potential benefit of requiring fewer processing/fabrication steps.

Furthermore, it is possible to selectively combine some of the above embodiments. For example, mold inserts fabricated by the release layer method described with respect to FIG. **7** can be coated in the manner described with respect to FIGS. **2** and **3**. Additionally, mold inserts fabricated by the embodiments of FIGS. **2** and **3** and FIG. **7** can be laminated in the manner discussed with respect to FIG. **6**.

While only certain preferred features of the invention have been illustrated and described herein, many modifications and changes will occur to those skilled in the art. It is, therefore, to be understood that the appended claims are intended to cover all such modifications and changes as fall within the true spirit of the invention.

What is claimed is:

1. A method for molding an optical disk comprising:

applying an adhesion promoter on a thermally conductive mold form;

coating a thermally insulative mold insert on the adhesion promoter and the thermally conductive mold form, the mold insert having a coefficient of thermal expansion compatible with the coefficient of thermal expansion of the mold form;

positioning the coated mold form in a thermally conductive mold apparatus with the mold insert positioned between the mold form and the mold apparatus;

injecting a molten thermoplastic material into the mold apparatus;

retaining the molten thermoplastic material in the mold apparatus for a time sufficient for the molten thermoplastic material to cool below its glass transition temperature to form the optical disk; and

ejecting the optical disk from the mold apparatus.

2. The method of claim **1** wherein the thermally insulative mold insert comprises at least two layers of thermally insulative mold insert material and wherein the step of coating includes coating a first layer of thermally insulative mold insert material on the mold form, at least partially curing the first layer of thermally insulative mold insert material, coating a second layer of thermally insulative mold insert material, and curing the second layer of insulative mold insert material.

3. The method of claim **1** wherein coating comprises spin coating.

4. The method of claim 1 wherein the mold insert comprises a polyimide.

5. The method of claim 1 wherein coating comprises spray, dip, or meniscus coating the thermally insulative mold insert onto the thermally conductive mold form.

6. A method for molding an optical disk comprising:

applying a thermally insulative mold insert having minimal surface features to an adhesive coated metal frame,

heating the thermally insulative mold insert and the metal frame,

cooling the thermally insulative mold insert and the metal frame, and then

applying a thermally insulative insert coating by spin, spray, dip, or meniscus coating the thermally insulative insert coating to the thermally insulative mold insert to provide at least one coated mold insert having a reduced surface roughness,

positioning the at least one coated mold insert between a thermally conductive mold form and a portion of a thermally conductive mold apparatus,

injecting a molten thermoplastic material into the mold apparatus,

retaining the molten thermoplastic in the mold apparatus for a time sufficient for the molten thermoplastic material to cool below its glass transition temperature to form the optical disk, and

ejecting the optical disk from the mold apparatus.

7. A method for molding an optical disk comprising:

securing a thermally insulative mold insert having minimal surface features between two metal rings to provide a flat surface of the thermally insulative mold insert;

applying a thermally insulative insert coating by spin, spray, dip, or meniscus coating the thermally insulative insert coating to at least one thermally insulative mold insert to provide at least one coated mold insert having a reduced surface roughness;

positioning the at least one coated mold insert between a thermally conductive mold form and a portion of a thermally conductive mold apparatus;

injecting a molten thermoplastic material into the mold apparatus;

retaining the molten thermoplastic in the mold apparatus for a time sufficient for the molten thermoplastic material to cool below its glass transition temperature to form the optical disk; and

ejecting the optical disk from the mold apparatus.

8. A thermally conductive mold form and a thermally insulative mold insert for being positioned in a mold apparatus for molding molten thermoplastic material into finished optical disks, the mold form and the mold insert comprising

a layer comprising an adhesive or an adhesion promoter overlying the mold form,

the mold insert being situated on the layer and the mold form, the mold insert having a coefficient of thermal expansion compatible with the coefficient of thermal expansion of the mold form.

9. The mold form of claim 8 wherein the layer comprises an adhesive, the adhesive comprising a material which does not significantly shrink and which has a coefficient of thermal expansion compatible with the coefficients of thermal expansion of the mold form and the mold insert.

10. An optical disk mold apparatus comprising:

at least one thermally conductive mold form

at least one thermally insulative mold insert, the mold insert having a coefficient of thermal expansion compatible with the coefficient of thermal expansion of the mold form;

a layer comprising an adhesive or an adhesion promoter overlying the mold form, the mold insert positioned on the layer and the mold form; and

a thermally conductive mold apparatus,

the at least one coated mold insert positioned between the thermally conductive mold form and a portion of the thermally conductive mold apparatus.

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